

WHAT IS CLAIMED IS:

1. An illumination apparatus for illuminating a surface to be illuminated with a radiation, comprising:

- a radiation source;
- a zoom optical system;
- an optical integrator; and
- a radiation beam adjustor which is arranged in an optical path between the radiation source and the optical integrator;

wherein the radiation beam adjustor generates at least a multipole radiation distribution in an illumination pupil, and

wherein the multipole radiation distribution can be continuously varied.

2. The illumination apparatus according to claim 1, wherein the radiation beam adjustor is arranged in an optical path between the radiation source and the zoom optical system.

3. The illumination apparatus according to claim 1, wherein the radiation beam adjustor includes a plurality of optical surfaces which are arranged in an array.

4. The illumination apparatus according to claim 3, wherein the plurality of optical surfaces deflect a radiation beam from the radiation source to plural directions.

5. The illumination apparatus according to claim 4, wherein the plurality of optical surfaces include a refractive surface.

6. The illumination apparatus according to claim 1, wherein the radiation beam adjustor includes a diffuser.

7. The illumination apparatus according to claim 6, wherein the radiation beam adjustor deflects a radiation beam from the radiation source to plural directions.

8. The illumination apparatus according to claim 1, further comprising a polarization reliever.

9. The illumination apparatus according to claim 8, wherein the polarization reliever includes an optical member made of quartz.

10. The illumination apparatus according to claim 9, wherein the optical member made of quartz includes a quartz prism.

11. The illumination apparatus according to claim 8, wherein the polarization reliever is arranged in an optical path between the radiation source and the radiation beam adjustor.

12. The illumination apparatus according to claim 1, wherein the radiation beam adjustor includes a refractive element.

13. The illumination apparatus according to claim 1, wherein the multipole radiation distribution includes dipole, quadrupole, or octpole.

14. The illumination apparatus according to claim 1, wherein the multipole radiation distribution includes a multipole with on-axis pole.

15. The illumination apparatus according to claim 1, wherein the radiation beam adjustor generates an annular radiation distribution.

16. The illumination apparatus according to claim 15, wherein the radiation beam adjustor includes a first element which is arranged in an illumination optical path when the multipole radiation distribution is generated, and a second element which is arranged in the illumination optical path when the annular radiation distribution is generated.

17. The illumination apparatus according to claim 1, wherein the zoom optical system changes the multipole radiation distribution continuously.

18. The illumination apparatus according to claim 1, wherein the radiation beam adjustor generates a radiation distribution for a conventional illumination.

19. The illumination apparatus according to claim 18, wherein the radiation beam adjustor includes a first element which is arranged in an illumination optical path

when the multipole radiation distribution is generated, and a second element which is arranged in the illumination optical path when the radiation distribution for the conventional illumination is generated.

20. A projection exposure apparatus for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising:

the illumination apparatus according to claim 1 which illuminates the mask,

wherein the illumination pupil of the illumination apparatus is conjugate with a pupil of the projection optical system.

21. A projection exposure method for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising the steps of:

illuminating the mask with the illumination apparatus according to claim 1; and

projecting the pattern on the mask onto a workpiece.

22. An illumination apparatus for illuminating a surface to be illuminated with a radiation, comprising:

a radiation source;

an adjusting optics including a plurality of optical elements; and

an optical integrator,

wherein the adjusting optics controls an inner and/or outer radial extent of an illumination distribution on an illumination pupil,

wherein the plurality of optical elements can be inserted in an illumination optical path,

wherein each of the plurality of optical elements defines at least one parameter of the illumination distribution on the illumination pupil, and

wherein at least two of the plurality of optical elements can be arranged in the illumination optical path simultaneously.

23. The illumination apparatus according to claim 22, wherein the plurality of optical elements include a refractive element.

24. The illumination apparatus according to claim 22, wherein the adjusting optics forms a multipole illumination

distribution and/or an annular illumination distribution in the illumination pupil.

25. The illumination apparatus according to claim 24, wherein the adjusting optics includes a zoom optical system.

26. The illumination apparatus according to claim 24, wherein the plurality of optical elements include a plurality of optical surfaces which are arranged in an array.

27. A projection exposure apparatus for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising:

the illumination apparatus according to claim 22 which illuminates the mask,

wherein the illumination pupil of the illumination apparatus is conjugate with a pupil of the projection optical system.

28. A projection exposure method for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising the steps of:

illuminating the mask with the illumination apparatus according to claim 22; and

projecting the pattern on the mask onto a workpiece.

29. An illumination apparatus for illuminating a surface to be illuminated with a radiation, comprising:

a radiation source;

an adjusting optics including a plurality of optical elements; and

an optical integrator,

wherein the adjusting optics controls an inner and/or outer radial extent of an illumination distribution on an illumination pupil,

wherein the plurality of optical elements can be inserted in an illumination optical path,

wherein each of the plurality of optical elements define at least one parameter of the illumination distribution on the illumination pupil, and

wherein the adjusting optics excludes an axicon.

30. The illumination apparatus according to claim 29, wherein the plurality of optical elements include a refractive element.

31. The illumination apparatus according to claim 29, wherein the adjusting optics forms a multipole illumination distribution and/or an annular illumination distribution in the illumination pupil.

32. The illumination apparatus according to claim 31, wherein the adjusting optics includes a zoom optical system.

33. The illumination apparatus according to claim 31, wherein the plurality of optical elements include a plurality of optical surfaces which are arranged in an array.

34. A projection exposure apparatus for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising:

the illumination apparatus according to claim 29 which illuminates the mask,

wherein the illumination pupil of the illumination apparatus is conjugate with a pupil of the projection optical system.

35. A projection exposure method for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising the steps of:

illuminating the mask with the illumination apparatus according to claim 29; and

projecting the pattern on the mask onto a workpiece.

36. An illumination apparatus for illuminating a surface to be illuminated with a radiation, comprising:

a radiation source;

a first member with a plurality of elements arranged in an array;

a second member with a plurality of elements arranged in an array,

wherein the plurality of elements of the first and the second member are each assigned to light channels, and the plurality of elements are configured or arranged such that a continuous beam path from the radiation source to the

surface to be illuminated results for each light channel,
and

wherein the assignment can be manipulated such that,
by assigning the plurality of elements of the first to the
second member, a predetermined illumination is adjusted in
an illumination pupil of the illumination apparatus.

37. The illumination apparatus according to claim
36, wherein the second member comprises such a number of
elements that at least two predetermined illuminations can
be adjusted by changing the assignment of the plurality of
elements of the first member to the plurality of elements
of the second member, without having to replace the second
member.

38. The illumination apparatus according to claim
37, wherein the first member with the plurality of elements
can be exchanged and by replacing the first member it is
possible to achieve a different assignment of the plurality
of elements of the first member to the plurality of
elements of the second member and thereby a different
illumination in the illumination pupil.

39. The illumination apparatus according to claim 38, further comprising a holder which holds a plurality of the first members, wherein the first members can be replaced by operation of the holder.

40. The illumination apparatus according to claim 36, wherein the first member is arranged in an optical path between the radiation source and the second member.

41. The illumination apparatus according to claim 36, wherein the light channels between the first member with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is annular-shaped.

42. The illumination apparatus according to claim 36, wherein the light channels between the first member with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is multipole-shaped.

43. The illumination apparatus according to claim 36, wherein the light channels between the first member

with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is an illumination for a conventional illumination.

44. A projection exposure apparatus for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising:

the illumination apparatus according to claim 36 which illuminates the mask,

wherein the illumination pupil of the illumination apparatus is conjugate with a pupil of the projection optical system.

45. A projection exposure method for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising the steps of:

illuminating the mask with the illumination apparatus according to claim 36; and

projecting the pattern on the mask onto a workpiece.

46. An illumination apparatus for illuminating a surface to be illuminated with a radiation, comprising:

a radiation source;

a first member with a plurality of elements arranged in an array;

a second member with a plurality of elements arranged in an array,

wherein the plurality of elements of the first and the second member are each assigned to light channels, and the plurality of elements are configured or arranged such that a continuous beam path from the radiation source to the surface to be illuminated results for each light channel, and

the second member with the plurality of elements can be exchanged and at least one particular illumination in an illumination pupil can be achieved with each second member, so that by replacing the second member, a different assignment of the plurality of elements of the first member with the plurality of elements of the second member is realized.

47. The illumination apparatus according to claim 46, wherein the first member is exchangeable.

48. The illumination apparatus according to claim 46, wherein the plurality of elements of the first member are imaged in the surface to be illuminated and the light channels are superimposed on each other in the surface to be illuminated.

49. The illumination apparatus according to claim 46, wherein the plurality of elements of the first member produce secondary radiation sources near the plurality of elements of the second member.

50. The illumination apparatus according to claim 49, further comprising an optical system which is arranged in an optical path between the second member and the surface to be illuminated and which images the secondary radiation sources to the illumination pupil.

51. The illumination apparatus according to claim 46, wherein the light channels between the first member with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is annular-shaped.

52. The illumination apparatus according to claim 46, wherein the light channels between the first member with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is multipole-shaped.

53. The illumination apparatus according to claim 46, wherein the light channels between the first member with the plurality of elements and the second member with the plurality of elements are configured such that the illumination in the illumination pupil is an illumination for conventional illumination.

54. A projection exposure apparatus for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising:

the illumination apparatus according to claim 46 which illuminates the mask,

wherein the illumination pupil of the illumination apparatus is conjugate with a pupil of the projection optical system.

55. A projection exposure method for projecting a pattern on a mask onto a workpiece through a projection optical system, comprising the steps of:

illuminating the mask with the illumination apparatus according to claim 46; and

projecting the pattern on the mask onto a workpiece.